ENVIRONMENTAL ASSESSMENT

FOR THE RELEASE AND ESTABLISHMENT OF *PSEUDOSCYMNUS TSUGAE* (COLEOPTERA: COCCINELLIDAE) AS A BIOLOGICAL CONTROL AGENT FOR HEMLOCK WOOLLY ADELGID

May, 1999

USDA Forest Service
Northeastern Area

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I. PURPOSE AND NEED FOR ACTION

1. Proposed Action:

The proposed project will involve the release of laboratory reared *Pseudoscymnus tsugae,* Sasaji and McClure in hemlock woolly adelgid (*Adelges tsugae,* Annand) infested hemlock stands for the purpose of accelerating the establishment and evaluation of this predator beetle. Small scale releases of 1,000-3,600 beetles in CT and VA in 1995-1997 has demonstrated *P. tsugae's* potential to control hemlock woolly adelgid (HWA) densities on release trees. The proposed releases would be conducted on a larger scale sometime in May/June, 1999 and consist of the inoculating 10,000 *P. tsugae* beetles per release site in Connecticut, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, West Virginia, Virginia, and North Carolina (Appendix 1). Monitoring and evaluation efforts will continue for 3 years to document establishment and dispersal of the beetle, evaluate its effectiveness in reducing HWA population densities and protecting hemlock health on a stand level basis. The New Jersey Department of Agriculture is currently rearing *P. tsugae* for this purpose at the Phillip Alampi Beneficial Insect Laboratory near Trenton. Forest Health specialists from each state will be provided a workplan with protocols to follow (Appendix 2). State participants will select release sites, conduct the releases, monitor beetle dispersal, changes in HWA population densities, conduct tree health assessments, and report their results to the USDA Forest Service. The USDA Forest Service will compile and analyze the collected data in cooperation with the Connecticut Agricultural Experiment Station. The USDA Forest Service will also provide each cooperating state with a brief, timely summary of each year's results.

2. Need for Action:

Native to Japan, HWA is a serious pest in the United States of eastern hemlock *Tsugae canandensis* and a threat to Carolina hemlock *T. caroliana*. The latter tree species found only in the southern region of the Appalachian Mountains. HWA is currently established in eleven eastern states from North Carolina to Massachusetts and tree decline and mortality has increased since the late 1980's. New Jersey estimates a loss of 9% of it's hemlock resource and 44% is moderately to severely impacted. Comparable conditions exist in Connecticut and Virginia.

HWA was first reported in the western U.S. in the 1920's. HWA on western species including western hemlock, *Tsugae heterophylla* and mountain hemlock, *T. mertensiana* appears innocuous and are believed to be resistant as little damage has ever been reported. In the East, HWA was first reported in the 1950's near Richmond, VA. Here it was more of an urban landscape pest controlled using insecticides and ground spraying equipment. The adelgid was periodically reported in the mid-Atlantic states in the 1960's and 1970's but it wasn't until the 1980's that HWA populations began to surge and spread northward to New England at an alarming rate. By 1988, HWA was causing extensive hemlock decline and tree mortality in hemlock forests throughout the East.

HWA control on individual trees in urban landscapes can be accomplished using insecticides like horticultural oils and insecticidal soaps, providing there is access to the trees for ground spraying equipment and the entire crown can be saturated. There are no insecticide treatment options available for controlling HWA in the forest environment.

The HWA is parthenogenetic (all female), has 2 generations a year, and each adult adelgid can produce between 50-300 eggs. Natural mortality in HWA populations is commonly between 30-60 percent but the reproduction potential is exponential. Significant natural mortality is
generally attributed to two causes: 1) extended period of cold temperatures that coincide with a susceptible period of development for HWA; and/or 2) sufficient loss of the nutritional quality of the food source that is associated with the decline in health and vigor of the host tree. Natural enemies capable of maintaining low HWA population levels do not occur in North America. Managing HWA will require establishing biological control agents if we are to succeed at reducing the impacts of HWA on hemlock in our forests. In 1992, Dr. Mark McClure (Connecticut Agricultural Experiment Station) discovered *P. tsugae,* a tiny ladybird beetle in Japan where it feeds exclusively on HWA. The beetle was brought to the U.S., screened in quarantine and evaluated to determine its suitability as a bio-control agent for HWA in this country. Extensive laboratory and field tests have demonstrated *P. tsugae* is an excellent candidate. In 1995, the USDA Animal and Plant Health Inspection Service (APHIS) issued Permit Number 950678 to the CT Agricultural Experiment Station to release *P. tsugae* in Connecticut.

3. Project Objectives:

1. To establish *P. tsugae* in a subset of hemlock stands currently infested with HWA.
2. To evaluate *P. tsugae's* impact on HWA populations and protecting tree health at a stand level.

4. Long-term Goal:

To expedite the natural spread of *P. tsugae* throughout the range of HWA and reduce HWA impact on hemlock.

5. Decisions to be Made:

The Cooperative Forestry Assistance Act of 1978 [16 U.S.C. section 2101 (note)] as amended by the Forest Stewardship Act of 1990 [16 U.S.C. section 2101 (note)] provides the authority for Federal and state cooperation in managing forest insect and diseases. The decisions to be made by the USDA Forest Service, based on the information included in this Environmental Assessment (EA)are:

1. Might the proposed action have significant impacts requiring further analysis in an Environmental Impact Statement (EIS)?
2. Should the USDA Forest Service provide assistance to the states in meeting the objectives for HWA suppression?

The responsible official for making these decisions for the Northeastern Area is:

John W. Hazel, Field Representative
Morgantown Field Office
Northeastern Area, State & Private Forestry
USDA Forest Service
180 Canfield Street
Morgantown, WV 26505

The responsible official will make these decisions on or about May 12, 1999, to ensure adequate time to conduct the necessary field work.
If no EIS is required and the assistance is approved, the decision will be documented in a Finding of No Significant Impact (FONSI).
Should the USDA Forest Service decide that an EIS is needed or choose not to participate in this project, the release of *P. tsugae* would proceed in 1999 without Federal involvement in Connecticut, Virginia and New Jersey using state resources but on a smaller scale. The New Jersey Department of Agriculture

could also provide beetles to other states for either small scale releases or as starter colonies for the purpose of rearing beetles for future releases.

6. Scope of this Environmental Assessment:

The environmental analysis documented in this EA will focus on the environmental consequences associated with new issues developed through the scoping process. Some previously identified issues associated with releasing non-indigenous organisms and their effect on non-target organisms and impacts on the human environment will continue to be carried through the analysis process. There are no known human health issues associated with this project nor will the implementation of this project have a negative impact on any wetlands or floodplains.
Two related EA's and FONSI's that were prepared for the decision making purpose of previous releases of *P. tsugae* and are referenced in this EA. The first EA and FONSI was prepared in 1995 by the USDA Animal and Plant Health Inspection Service to determine whether an EIS was needed prior to issuing a permit authorizing the release of *P. tsugae.* The second EA was prepared in 1998 by the Connecticut Agricultural Experiment Station to support the FONSI prepared by the USDA Forest Service to determine if an EIS was necessary prior to providing technical and financial support for beetle releases made in Connecticut. Both sets of documents are on file and available at the Morgantown Field Office location.

6a. Scoping Activities and Issues:

A summary of each participating state's scoping efforts involved in identifying potential issues is as follows:

Massachusetts: Meeting with the Quabbin Reservoir Management Staff, Quabbin Reservoir Forestry staff, Quabbin Reservoir Advisory Committee, University of Massachusetts Forestry and Entomology staff and the Massachusetts Department of Environmental Management (DEM) to discuss the release of *P. tsugae* at the Quabbin Reservoir. A second meeting was held and attended by the Executive Office of Environmental Affairs, Division of Fish and Wildlife, Natural Heritage Program, and DEM to discuss beetle releases on state lands. The proposed release site is in Hampden County.

Connecticut: Numerous presentations and discussions have been given regarding the release of *P. tsugae* in CT since 1995. These include: the Farmington Valley Watershed Association; Steep Rock Assoc. (Washington, CT); Marlborough Conservation Commission; CT Dept. of Environmental Protection; CT Dept. of Forestry; CT Fund for the Environment; CT Chapter of the Nature Conservancy; Northwest Park Nature Center (Windsor, CT); Roaring Brook Nature Center (Canton, CT); Metro. District Commission (CT and MA); Hartland Pond Assoc.(Hartland, CT); Mashuntucket Pequot Tribal Nation (CT); Roxbury (CT) Land Trust; Cheshire (CT) Land Trust; Yale Forest (Union, CT); Arnold Arboretum (MA); Trout Unlimited (New York Chapter); and the Sierra Club. All previous and proposed releases to date are located in Windham and Hartford Counties.

Rhode Island: The State Forester decided to use the RI Department of Environmental Northwest Management Council as a forum to identify potential issues. A letter was sent to each member regarding the proposed action for further distribution and comments. Members on this council represent the Divisions of Enforcement, Investigations, Fish & Wildlife, Parks & Recreation, and Agriculture. The proposed release site is in Providence County.

New York: The following agencies and organizations were contacted and briefed of the proposed releases: NY State Parks, Recreation and Historic Preservation; Mohonk Estate; Saugerties Environmental Management Council; Trout Unlimited; Department of Environmental Conservation Region 3; USDA APHIS; NY State Department of Agriculture and Markets; and Mt. Saint Mary College. The proposed release site is in Putnam County.

New Jersey: Permission, comments and concerns were addressed to all NJ state land managers responsible for areas considered for beetle releases including the NJ Division of Fish and Game, the Natural Lands Council, and NJ State Parks. A number of local newspapers and several TV Stations have been publishing stories on the beetle rearing efforts and releases made by the NJ Department of Agriculture and the impacts of HWA in New Jersey since 1998. Proposed release sites are in Sussex, Hunterdon, Morris, Warren and Passaic Counties. Previous releases in 1998 were conducted in Warren, Morris, Sussex, Mercer and Monmouth Counties.

Pennsylvania: In addition to an internal review among the staff of PA Bureau of Forestry, contacts were initiated with the PA Bureau of Plant Industries and the Bureau of State Parks for permission to release *P. tsugae* and solicit comments. The proposed release site is in Franklin County.

Maryland: The proposed action has been reviewed among Department of Agriculture Office of Plant Industries and Pest Management staff, and the staff of Plant Protection and Weed Management. Also, a press release was submitted in the proposed release area of Harford County.

West Virginia: Following permission for the release from the landowner, letters were sent to all adjacent private landowners with the opportunity to comment. The proposed release was discussed among staff members in the WV Department of Agriculture, and requests for comments were made to the Division of Natural Resources, Division of Culture and History, Division of Forestry, Potomic Valley Soil District, Hampshire County Extension Office, and the Potomic Headwaters RC&D. Articles in two local Hampshire County newspapers were also published to solicit comments or potential issues. The proposed release site is in Hampshire County.

North Carolina: In addition to discussions among staff members within the NC Dept. of Agriculture and Consumer Services Plant Industries Division, the State Clearinghouse was notified of the proposed beetle release and a press release was made to solicit comments. The proposed release site is in Stokes County.

Virginia: Since 1997, the VA Department of Forestry published several articles in the *Forest Health Monitoring Review* regarding the release of *P. tsugae* in Virginia. The VA Dept. of Agriculture and Consumer Services Division of Consumer Protection was consulted regarding the release and numerous presentations to both professional and lay persons have been conducted. The proposed release site in 1999 in Giles County.

6b. Issues Considered in Detail:

Issue 1: *P. tsugae* may impact other arthropod species especially native predators or parasites that rely on HWA as a food source.

Issue 2: *P. tsugae* could become a nuisance in human habitations.

Issue 3: HWA is increasingly causing tree decline and mortality of both eastern and Carolina hemlocks and could eliminate these species from our forests.

II. AFFECTED ENVIRONMENT

1. Characteristics of Hemlock Trees Vulnerable to HWA:

Eastern hemlock is a long-lived late successional/climax species that can typically dominate an undisturbed forest throughout its range (Quimby, 1996). Hemlocks may take centuries to reach maturity and live for more than 800 years. Eastern hemlock is widely distributed in southeastern Canada and in the United States from eastern Minnesota to Maine, south to Alabama and westward from New Jersey to the Appalachians. The range completely overlaps that of Carolina hemlock, a closely related species that is limited to the slopes of the Appalachians from Virginia to Georgia (Godman and Lancaster, 1990). The proportion of eastern hemlock has fallen considerably as a result of past harvesting practices in Michigan and the Allegheny Plateau and the remaining sawtimber size trees are concentrated mainly in New England. Throughout much of the remaining range, stands dominated by hemlock tend to be patchy in distribution.

Hemlock is the most shade tolerant tree species in North America and is capable of surviving more than 350 years in a suppressed state (Quimby, 1996). Old suppressed hemlocks are reported to respond quite well when openings in the overstory occur, giving it the ability to outlast other species if adequate moisture and soil conditions exist. Hemlock grows best on north and east facing slopes and coves where the climate is relatively cool and soils remain moist. Mature hemlock forests perpetuate themselves by their dense canopy that shades out most other understory species while maintaining this cool moist environment. When an understory does exist, the most common herbs are false lily-of-the-valley *Mianthemum canadense,* starflower *Trientalis borealis,* woodfern *Dryopteris* spp., common woodsorrel *Oxalis montana,* goldthread *Coptis groenlandica,* clubmoss *Lycopodium* spp., and sedges *Carex* spp.. Common mosses include *Dicranum* and *Polytrichum* spp. (Godman and Landcaster, 1990). Eastern hemlock is a major component in 4 forest cover types, a common associate in 7 forest cover types and is a minor species component in 18 forest cover types throughout the East and Mid-west.

2. Associated Hemlock Values:

2a. Economical: Eastern hemlock has not been a highly valued timber species relative to other species utilized for timber products since the early 1800's. Once valued for its bark as a source of tannin for the leather industry, the importance of hemlock has recently begun growing again, as a source of wood fiber for the pulp and paper industry and for structural lumber. Quimby (1996) reported that in 1988, the consumption of sawlogs in Pennsylvania was 27 million board feet and more than twice that of white pine. A New York based timber company manages specifically for hemlock and has contributed tens of thousands of dollars over the past several years in support of research to reduce the threat of the hemlock woolly adelgid (Reardon, pers.com., 1999).

2b. Aesthetics: In the east, the hemlock is commonly used as an ornamental planting in the urban landscape and is highly valued when grown either as a tree or maintained as a shrub. It's dense foliage and persistent lower branches make it aesthetically pleasing and an excellent choice for use as a noise absorber, shade tree, wind break and for general visual screening purposes. There are 274 cultivars of eastern hemlock, making it one of the most cultured and cultivated landscape trees in the U.S. (McClure, et al., 1996). The eastern hemlock is also the Official State Tree of Pennsylvania.

Hemlock is considered a major component of eastern old growth forests and is a highly valued resource in prime recreational areas and parks throughout the east. The pristine nature of a mature hemlock forest and the tendency for hemlocks to grow near mountain streams and lakes affords millions of visitors an aesthetically pleasing experience. The dense hemlock canopy offers a cool shaded environment to enjoy in the summer and a wind sheltered outdoor experience on cold winter days.

2c. Ecological: Eastern hemlock is considered to be an ecologically important tree species and in many cases, irreplaceable. A number of wildlife species benefit from the environment that exits in hemlock stands including birds, fish, invertebrates, amphibians, reptiles and mammals (Lapin, 1994). Although most wildlife species are not limited to hemlock for their habitat requirements, many species will select hemlock trees and forests for food, shelter or breeding purposes. Examples of some common wildlife species frequently associated with hemlock ecosystems are offered below.

Birds:
Three bird species were found to be almost exclusively in hemlock stands in New Jersey and include the black-throated green warbler *Denroica virons*, the solitary vireo *Vireo solitarius* and the northern goshawk *Accipiter gentilis* (Benzinger, 1994). In a study at the Delaware Water Gap Recreational Area in northeastern Pennsylvania, twenty-two breeding bird species were documented in hemlock ravines. Three of these species breed primarily in hemlock stands and were relatively abundant. These included the black-throated green warbler, the solitary vireo and the blackburnian warbler *Dendroica fusca* (Evans et al., 1996).

Aquatic Invertebrates and Trout:
Indirect impacts on the benthic invertebrate fauna are difficult to document but are possibly more important than the use of hemlock as food and shelter for invertebrates (Lapin, 1994). Small changes in stream temperature, dissolved oxygen and light conditions, particularly in already marginal waters can have detrimental affects on aquatic insects and consequently the fisheries that rely on them as a food source. Temperature sensitive aquatic wildlife such as brook trout *Salvelinus fontinalis* are found more commonly in streams associated with hemlock ecosystems because of the shaded cooling effect of the hemlock canopy (Quimby, 1996). Studies show that the removal of riparian vegetation, especially within 80 feet of the stream, can cause a temperature elevation of 6 to 9 degrees Celsius (Lapin, 1994). Likewise, studies of stream temperatures associated with hemlock ravines in northeastern Pennsylvania showed water temperatures were consistently 3° C to 4°C cooler at the lower end of the ravines than at the upper end (Evans, et al, 1996). In riparian areas where hemlocks are predominant, hemlock trees help stabilize soils and protect lakes and streams from sedimentation, particularly when growing on steep slopes and ravines.

Terrestrial Arthropods:
While a comprehensive list of arthropod species closely linked or exclusive to eastern hemlock appears nonexistent (Lapin, 1994), Futuyma and Gould (1979) found insect density and diversity on hemlocks lower than on most deciduous trees. In an arthropod diversity study using pitfall traps in two hemlock ravines at the Delaware Water Gap National Recreation Area, beetles represented the largest group of terrestrial arthropods captured in both abundance (44 percent) and specie richness (60 percent). Ants and harvestmen were the second and third largest groups captured (Schrot, 1998). Numerous studies noted by Benzinger (1994) indicate that spiders tend to be in larger numbers on hemlocks and other conifers than on hardwoods. Of the known lepidoptera associated with hemlock, only the hemlock angle *Semiothisa fissinotata* is considered an obligate of eastern and Carolina hemlock (Lapin, 1994). Some of the more common pests of hemlock include two scale insects (elongate and hemlock scale), several mites (eriophyids and spider mites), needleminers, hemlock borer and the hemlock looper.

Mammals:
Numerous species of mammals utilize hemlock forests. Lapin (1994) reported a total of 36 mammal species are known to occur in hemlocks within Connecticut. In the more northern climates, whitetailed deer will seek out hemlock forests for food and shelter during the winter months. Larger more mobile species tend to be transient and may occupy hemlock habitat for hunting, foraging, denning or breeding. Black bear, whitetail deer, raccoon, red and grey fox, coyote, snowshoe hare and cottontail rabbits are examples of transient mammals often found in hemlock forests. Smaller less mobile mammals such as red-backed vole, smokey shrew, white-footed mice, and masked shrews are common in hemlock forests but are also associated with other habitat types. In a study by Evans et al, 1996, 7 rodent

and 5 soricid mammal species were collected in hemlock ravines in northeastern Pennsylvania including a Northern water shrew *Sorex palustris* and a pygmy shrew *Sorex hoyi*, both of which are considered rare for that area. Hemlock ravines in northeastern Pennsylvania and northwestern New Jersey apparently support a relatively high number of small mammal species and a high total small mammal population density as compared to similar studies conducted in other habitat types (Evans, et al, 1996). Red squirrels occur mainly in coniferous forests and when associated with hemlock habitat, hemlock seed makes up a substantial portion of their winter diet (Benzinger, 1994).

2d. Non-Target Organisms: In Japan, the native home of *P. tsugae*, the predator attacks only HWA. In the United States, *P. tsugae* is expected to attack only HWA and possibly a few other species of adelgid pests (McClure, Cheah, 1998). Laboratory experiments have demonstrated larvae and adult *P. tsugae* will feed on pine bark adelgid, *Pineus strobi,* Cooley spruce gall adelgid, *Adelges cooleyi* and the balsam woolly adelgid, *A. piceae*. It is possible that these and perhaps other adelgids may provide an alternative food source where there is overlap in distribution or where HWA is sparse but this would be beneficial, as these are all forest pests. Laboratory observations on prey choice have confirmed that *P. tsugae* does not accept or attack other arthropod fauna known to be associated with hemlock (Cheah, 1998).

2e. Threatened and Endangered Species: There are no known threatened or endangered species that could be negatively impacted by the release and establishment of *P. tsugae.* The genus *Pseudoscymnus* originates from Asia and Africa where known prey species records include mealybugs, mites, scales and gall-making aphids, all of which are pests (Cheah, 1998). Because *P. tsugae* is highly selective towards adelgids and there are no obligate native predators of HWA, no direct or indirect impacts on non-target organisms including any possible unknown T&E predator species is expected to occur. The U.S. Fish and Wildlife Service concurs that there are no known federally listed Threatened or Endangered Species that would be impacted by the release of this beetle (Appendix 3).

2f. Historical and Cultural Resources: The release and establishment of *P. tsugae* will have no effect on any item listed on or eligible for listing on the National Register of Historic Places, nor will it cause loss of significant scientific, cultural, or historical resources.

2g. Wetlands and Floodplains: Wetlands and floodplains are sensitive environments and require special consideration to determine potential impacts. Natural hemlock stands typically grow in riparian areas of which are often classified as wetlands or floodplains. Outside of adelgids, the release and establishment of *P. tsugae* will have no negative impact on any organism associated with wetlands or floodplains. Once established, *P. tsugae* is expected to protect hemlock trees and forests by reducing HWA populations.

III. ALTERNATIVES INCLUDING THE PROPOSED ACTION

This EA considers two alternatives: 1) No action; and 2) Proposed Action. As the proposed action is designed to also serve as an evaluation, the alternatives are limited in scope. This section will summarize the likely consequences of these alternatives.

Alternative 1: (No Action) The USDA Forest Service will not support the release of *P. tsugae* in 1999 to establish, monitor and evaluate the effectiveness of this predator beetle in controlling HWA populations and reducing hemlock tree decline and mortality.

This alternative is considered the environmental baseline (the no action alternative). As a result, HWA populations would be allowed to increase and decrease naturally, without intervention in eastern hemlock forests.

Alternative 2: (Proposed Action) The USDA Forest Service will coordinate the release of *P. tsugae* in 1999 in as many as 10 states currently infested with HWA for the purpose of establishing and evaluating the effectiveness of this predator beetle in controlling HWA populations.

This alternative would provide a systematic method of establishing and evaluating *P. tsugae* as a biological control agent that has thus far demonstrated to be an effective predator of the HWA. The actual number of states participating in the releases will be dependent on the number of beetles available in May and is unknown at this time. Release sites will involve hemlock stands that are at least 10 acres in size, trees that are still healthy and HWA populations have only recently become established. These conditions are necessary to provide an area of sufficient size to monitor beetle movement within the stand and the best conditions to evaluate the efficacy of the *P. tsugae* releases in reducing HWA populations and protecting tree health.

IV. ENVIRONMENTAL CONSEQUENCES

1. Alternative 1 (No Action):

Implementation of this alternative would eliminate those issues identified as concerns of the proposed action (Issues 1 and 2). Issue 3 regarding the loss of hemlocks in the forest environment however would continue, as no action would be taken to reduce HWA populations in natural setting.
In residential areas or where hemlocks grow near roads or trails that provide access for ground spraying equipment, landowners will still have the option to chemically treat individual trees as needed to protect them. In the forest environment however, there are no treatments available to minimize the impacts of tree decline and mortality caused by HWA.
Because HWA has a high reproductive capacity and has demonstrated the ability to rapidly spread in recent years, it is expected that HWA populations will continue to increase throughout the currently infested area and accelerate its spread to currently non-infested areas. Population densities will likely fluctuate periodically depending on severity of winters but this would likely be localized to the more northern climates and short in duration (1-2 years). HWA populations quickly rebound following such events and consequently, impacts to hemlock resources throughout the range of eastern and Carolina hemlock will increase as more hemlocks succumb to this adelgid pest.

2. Alternative 2 (Proposed Action):

P. tsugae is a non-indigenous species that will be introduced into the hemlock environment for the purpose of self perpetuation at the expense of a previously established exotic pest. Once established, *P. tsugae* will continue to reproduce and populations will increase as long as there are sufficient populations of HWA to sustain it. Once food sources are depleted on individual trees and within the general area, it is anticipated that *P. tsugae* will move to other areas in search of it's host food source, the HWA. Should other adelgids be located, it is likely that the beetles will attack these pests. If sufficient numbers of HWA or other adelgid pests are located, *P. tsugae* will likely perpetuate and continue to establish in other HWA infested areas. Population densities of *P. tsugae* will be directly related to the availability and nutritional quality of HWA or other adelgid pests. We expect the dispersal of *P. tsugae* throughout the HWA infested area will take years to accomplish even with future mass rearing and release efforts. It is likely that hemlock decline and mortality as a result of HWA will continue in the meantime. We do not know to what extent other insect predator species will predate on *P. tsugae* .
Because there are no native predator species capable of maintaining low level HWA populations, the success of the proposed action and future related biological control efforts involving the introduction of non-indigenous HWA predators is the only means available to reduce the impact of HWA on hemlocks in the forest environment.

Issue 1: *P. tsugae* may impact other arthropod species especially native predators or parasites that rely on HWA as a food source

There are no known parasites of HWA in either this country or their country of origin. There are no other arthropod species federally or state listed as endangered or threatened that utilize HWA as a food source; hence, no species will be affected by the release of *P. tsugae.* Of the native or introduced beetles found in the natural hemlock habitat, none appear to be dependent on HWA and all have an alternate host preference. Beetle predators sometimes found associated with hemlock habitat include: twicestabbed lady beetle *Chilochorus stigma* (Say) which predates hemlock scales; Halloween beetle *Harmonia axyridis* Pallas which is primarily aphidophagous but will opportunistically feed on adelgid; *Scymnus suturalis* Thunberg, a common predator of the *Pineus* sp. but will occasional feed on HWA; and *Laricobius rubidus* LeConte, a derodontid beetle that feeds primarily on *Pineus strobi* on white pine but will also feed on HWA (Montgomery,1999). Brown lacewing, midge and syrphid larvae have also been observed in association with HWA in Connecticut but in low numbers (Montgomery, 1999). Cecidomyiid, syrphid and chrysopid larvae are sometimes associated with egg masses of the HWA at low densities but all are generalists that also feed on mites, aphids and other insect larvae (Cheah, 1998). None of these predators either individually or collectively have a substantial impact on HWA populations (Montgomery and Lyons, 1996, Hain, pers. com., 1999).

Issue 2: *P. tsugae* could become a nuisance to human habitations

Behavioral studies indicate that *P. tsugae* does not aggregate in large numbers prior to overwintering as was the case with another non-indigenous lady beetle *Harmonia axyridis* that was introduced into the U.S. for biological control of aphids. *P. tsugae* does not leave the forest to overwinter and observations suggest that this species hibernates in the leaf litter (Cheah,1998). *P. tsugae* is also incapable of transferring to non-adelgid prey and populations are expected to decrease as HWA densities decline. In contrast, *H. axyridis*, a generalist predator, is able to maintain high densities by switching over to other more abundant prey (Hennessey and McClure, 1995). Based on both laboratory and field observations and the biological nature of *P. tsugae*, there is little chance *P. tsugae* could become a nuisance to either humans or human habitation.

Issue 3: HWA is increasingly causing tree decline and mortality of both eastern and Carolina hemlocks and could eliminate these species from our forests

P. tsugae has been shown to be an aggressive HWA predator and is expected to play a significant role in reducing HWA populations. It is not known however, if this predator beetle will be the only predator necessary to maintain low level populations of HWA to prevent future loss of hemlocks on a stand and regional basis. If the proposed action is successful and demonstrates *P. tsugae* can reduce HWA populations and protect hemlocks on a stand level basis, it would still take years before beetle populations could spread and become effectively established throughout the HWA infested region. Expanding rearing and release efforts of *P. tsugae* would shorten this timeframe considerably. The proposed action is an attempt to address this issue while evaluating how we can optimize future HWA management by improving release strategies.

V. LIST OF PREPARERS

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VI. LIST OF PERSONS AND AGENCIES CONSULTED

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Charlie Burnham, MA Dept. of Environmental Management. Release coordiination and State scoping activities.

Bob Chianese, NJ Department of Agriculture. Release coordination, primary rearing facility, and State scoping activities.

Lloyd Garcia, NC Department of Agriculture and Consumer Services. Release coordination and State scoping activities.

Sherri Hutchinson, WV Dept. of Agriculture. Release coordination and State scoping activities.

Mark McClure and Carol Cheah, CT Agricultural Experiment Station. Release coordination, release protocol development and project evaluation.

Bob Rabaglia, MD Department of Agriculture. Release coordination and State scoping activities.

Glenn Smith, USDI Fish and Wildlife Service. Section 7 Consultation

Cathy Sparks, RI Dept. of Environmental Management. Release coordination and State scoping activities.

Tim Tigner, VA Department of Forestry. Release coordination and scoping activities.

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APPENDICES